REMARKS

Applicant's attorney wishes to thank the Examiner and his SPE, Mr. Diego Gutierrez, for the careful consideration given this case. During the telephonic interview held March 9, 2004, the issues presented in the January 13, 2004 Office Action were fully discussed and the issues remaining are (i) the Examiner's requirement of evidence of "Longfelt Need" and (ii) rebuttal of the implication of "routine experimentation." Applicant does not agree that a case of prima facia obviousness has been properly made out, nonetheless, these two remaining issues are fully addressed below.

Claims Remaining

Claims 2-13 and 15-25 are currently pending in this application.

Claim 1 has been cancelled without prejudice and been replaced with Claim 25, and all claims that previously depended from Claim 1 have been amended to now depend from Claim 25.

Claims 22 & 23 are allowed.

In light of the amendment and agreement reached with the Examiners during the telephonic interview regarding the §112 issue, and the additional remarks being provided herewith regarding the nonobviousness of the pending claims, it is believed that all currently pending claims not previously allowed, are now allowable. Early confirmation of the allowability of these remaining claims is respectfully requested.

Nonobviousness

During the March 9, 2004 interview, and as reflected in the written interview summary, the Examiner invited the applicant to demonstrate the Longfelt need and failure of others to achieve this invention. As a starting point, the references of record in this application are replete

with objective evidence of both (i) the desirability of obtaining a harmonic bell; and (ii) the supposed impossibility of doing so. *See, e.g.* Collins Encyclopedia of Music; also The Designing of Swinging Bells and Carillon Bells in The Past and Present by Dr. A. Lehr (1987)(both references were raised by Examiner in the August 22, 2002 Office Action). Additional evidence of the nonobviousness of Applicants' invention pursuant to MPEP §716.04 is set forth in the declaration of Dr. Thomas Rossing, submitted herewith.

In two of the three previous Office Actions in this application (those mailed on August 22, 2002 and May 20, 2003), the Examiner relied upon the supposed impossibility of achieving such an invention (as set forth in those same references cited above) to reject claims under 35 USC §101. Up until Applicant's response to the May 20, 2003 Office Action, at which time Applicant provided evidence that they had indeed made a harmonic bell, the Examiner persisted in crediting the prior art "impossibility" over Applicants' assertion of utility of the claimed invention. In the instant Office Action the Examiner acknowledges that harmonic bells are possible (*i.e.* meet 35 USC §101), but now asserts that such an invention is obvious in light of the very art previously relied upon to support its impossibility. This is the height of an improper hindsight rejection and should therefore be withdrawn.

Further, nothing relied upon by the Examiner provides any indication of a reasonable expectation of success of achieving Applicant's invention. As presented in Dr. Rossing's declaration, quite the opposite was the case for generations - *i.e.* there was no expectation of success using any means to achieve a harmonic bell.

Finally the Examiner has failed to point to a any prior art that teaches a harmonic bell. It is clear that harmonic bells never existed until the Applicant invented them. For these reasons (*i.e.* no expectation of success and no prior art teaching of harmonic bells), Applicant respectfully suggests that a prima facia case of obviousness has not been made out, and therefore requests that the rejection be withdrawn.

Routine Experimentation Would Not Lead To Applicant's Invention

During the interview the Examiner raised the novel assertion that the invention of the harmonic bell by the Applicant was a matter of 'routine experimentation' using finite element (FE) methods with an optimization algorithm. As demonstrated by Dr. Rossing's declaration and the remarks presented below, nothing could be further from the truth.

As Dr. Rossing's declaration supports, the techniques described in the specification of this application - for example, of choosing a starting geometry in which the lower frequency modes to be tuned by shape optimisation were purely circumferential modes - represent a substantial departure from standard design procedures in this technical field.

It is now apparent that the failure to develop a harmonic bell in the past has been partly due to the conventional historical belief that bells are simply not harmonic instruments, which has perhaps prejudiced designers from looking closely at this problem. The question faced by the inventors regarding the achievement of an harmonic bell was "what exactly does one have to optimize?" And this is far from a simple question.

In a three-dimensional shape such as a bell, the flexural vibrations mean that the behavior is extremely complex. Using a gradient projection method, one attempts to optimize the objective parameters (such as modal natural frequencies) by changing the coordinates of the FE nodes. The software used can compute the nodal vector sensitivities to the objective parameters as a function of the node coordinates. The sensitivity can be calculated from differences in the objective parameters after displacement of each active finite element node. The process of optimization then iterates towards a target in accordance with geometric constraints that preserve shape parameters of the model (such as rotational symmetry about the vertical axis).

Ideally, the optimization is performed separately on each vibrational mode. The optimization stops if progress toward the optimization objective cannot be achieved without altering the constrained parameters beyond a given tolerance. The user sets the step size to use in

the iterations, such as an initial iteration step and a reduction rate for the following iterations, in order to avoid overshoot.

The above process can perhaps be characterized as the normal, conventional steps in an FE design process, and admittedly, one can use objective parameters selected for the harmonic bell (the inventor selected the first 7 modes in a harmonic sequence). But, **as the inventor discovered**, the trial and error around this approach revealed that the behaviors of many bending modes are strongly correlated with respect to changes in the model geometry. In other words, **it was not possible to raise or lower any given partial frequency (in accordance with the above technique) without affecting other partial frequencies**. Thus, employing the "routine" approach failed to produce the desired harmonic bell. Constraining all the modes except the mode being optimized was found to restrict the process, and the objective could not be achieved. In other words, 'mere' application of the FE optimization technique did not lead to the design of an harmonic bell. The ultimate achievement of such a design was clearly far from a trivial matter.

In stepping away from the conventional approach, the inventor considered strategies that might overcome this problem that had been identified - strategies that went well beyond anything that might be considered 'normal' techniques'. Considerable effort was made by the inventor to solve this issue, as set out in the J. Acoust. Soc. Am. Article previously provided to the Examiner with the Applicant's September 19, 2003 response. To summarize, after many false starts and considerable inventive thought, one approach finally taken was to design an initial shape such that, of the partials to be tuned, no modes with ring nodes were at frequencies below modes without ring nodes. This means that the designer is predominantly using shape optimization to adjust the frequencies of approximately equally spaced, purely circumferential modes. It was discovered that only then was it possible to tune modes with ring nodes to harmonic frequencies

higher than any of the purely circumferential modes.[1] It was the above realization that finally led to the achievement of a solution converging to the objective criteria.

It is worth noting that carillon bells have purely circumferential modes and modes with ring nodes dispersed amongst their lower partial frequencies. The inventor now realizes that, starting with the geometry of carillon bells – **the only previously known** bells with more than two (2) musically tuned partial frequencies, made it **impossible** to tune a harmonic bell using shape optimization or any other means. In other words, it wasn't possible to start with the state of the art (carillon bells) and merely advance it - the inventors had to return to the basics and start over, beginning with their discovery regarding shape geometry, and then progressing beyond the state of the art to achieve a harmonic bell.

As all of this shows that, in spite of the long recognized desirability of a harmonic bell in the field of musical instruments, the prejudices militating against successfully achieving this objective conventionally led people away from considering this possibility very earnestly. Furthermore, the technical solution of the 'harmonic bell problem' has in the past eluded those who may have attempted to achieve this objective. In view of the complete absence in the past of harmonic bells, and yet the desirability of such bells having been understood in the field of musical acoustics for such a long time (indeed, over centuries),even those expert in modern design techniques have generally not been prompted to seriously explore this avenue. The outcome provided by the present invention does not fall in the category of "obvious to try".

Applicant would submit that very few people are sufficiently expert in modern design engineering, musical acoustics and musicology to understand the musical potential of

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[1] It will not be possible, however, to tune any purely circumferential modes that occur at frequencies higher than the modes with ring nodes, as they would be very unevenly distributed in frequency with respect to the latter. Purely circumferential modes tend to behave similarly to shape changes (as shown in Figures 1-5 of the present application), and so any large changes in frequency of the high frequency purely circumferential modes that are necessary to tune them in relation to the modes with ring nodes, will disturb the harmonic relationships established in the lower pitched purely circumferential modes.

harmonic bells, and in fact the present invention is an example of a significant migration of knowledge across the boundaries of several traditional disciplines.

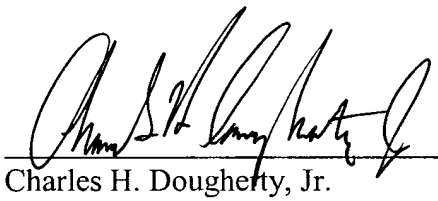
Finally, it should be emphasized that, although bells have been used in music for over 1,000 years, we do not find them in modern orchestras (except perhaps, as occasional sound effects) because they do not have harmonic overtones and hence reliable acoustic properties. This invention will allow bells to be introduced to orchestras and other western musical assemblies, which is undoubtedly a major accomplishment. This in itself provides very strong support for the inventiveness of this invention.

In summary, in light of the above remarks, taken together with the declaration by Dr. Rossing, the Examiner's contention regarding routine experimentation (*i.e.*, that the invention was (i) merely a matter of using a known program such as ReShape; (ii) entering simple boundary conditions (bell shape or wall thickness); (iii) setting the objective parameters (the modal frequencies); and (iv) iterating to the desired result) is respectfully traversed. Given the desirability of harmonic bells, the actual achievement of the solution was far from a trivial, and hence a nonobvious, matter.

In view of the foregoing remarks, it is believed that the remaining issues have been fully addressed, and the present application is now in condition for final allowance. Accordingly, early notice to such effect is respectfully requested. Should the Examiner or his SPE wish to discuss any aspect of this response, they are encouraged to contact Applicant's attorney at the number below.

Respectfully submitted,

Dated: June 18, 2004

By 

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